

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C 371**

U.S. APPLICATION NO. (If known, see
37 C.F.R. 1.5)

09/331226

INTERNATIONAL APPLICATION NO.
PCT/DE98/00512

INTERNATIONAL FILING DATE
January 5, 1998

PRIORITY DATE CLAIMED
January 3, 1997
January 16, 1997

TITLE OF INVENTION

DEVICE FOR NON-CONTACT TRANSMISSION OF ELECTRICAL SIGNALS AND/OR ENERGY

APPLICANT(S) FOR DO/EO/US

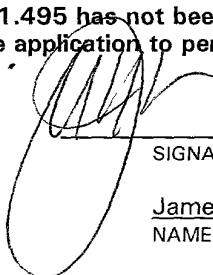
(1) Georg LOHR

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to immediately begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay the examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(I).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☒ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limited for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the Annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement Under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
3. ☒ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
4. ☐ A substitute specification.
5. ☐ A change of power of attorney and/or address letter.
6. ☐ Other items or information:

U.S. Application No. (If known, see 37 CFR 1.5)		INTERNATIONAL APPLICATION NO. PCT/DE98/00512		ATTORNEY'S DOCKET NUMBER 1384.1013/JDH			
17. <input checked="" type="checkbox"/> The following fees are submitted: Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO \$840.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) \$670.00 No International preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) . . \$760.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$970.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) \$96.00 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS		PTO USE ONLY	
				\$ 840.00			
				\$			
				\$			
				\$			
Claims	Number Filed	Number Extra	Rate				
Total Claims	36 - 20 =	16	X \$ 18.00	\$ 288.00			
Independent Claims	1 - 3 =	0	X \$ 78.00	\$.00			
Multiple dependent claim(s) (if applicable)			+ \$260.00	\$.00			
TOTAL OF ABOVE CALCULATIONS =				\$ 840.00			
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28)				\$			
SUBTOTAL =				\$ 1,128.00			
Processing fee of \$130.00 for furnishing the English translation later than [120 [130 months from the earliest claimed priority date (37 CFR 1.492(f)).				+	\$		
TOTAL NATIONAL FEE =				\$ 1,128.00			
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				+	\$ 0.00		
TOTAL FEES ENCLOSED =				\$ 1,128.00			
				Amount to be:			
				refunded	\$		
				charged	\$		
a. <input checked="" type="checkbox"/> A check in the amount of <u>\$1,128.00</u> to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. <u>19-3935</u> in the amount of \$_____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>19-3935</u> . A duplicate copy of this sheet is enclosed.							
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.							
SEND ALL CORRESPONDENCE TO: STAAS & HALSEY 700 Eleventh Street, N.W. Suite 500 Washington, D.C. 20001 Telephone: (202) 434-1500 Facsimile: (202) 434-1501			<div style="text-align: center;"> <u>June 17, 1999</u> DATE </div> <div style="text-align: center;">  SIGNATURE </div> <div style="text-align: center;"> <u>James D. Halsey, Jr.</u> NAME </div> <div style="text-align: center;"> <u>22,729</u> REGISTRATION NUMBER </div>				

DOCKET NO. 1384.1013/JDH

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application:

Georg LOHR

Serial No.: New Group: Unassigned

Filed: June 18, 1999 Examiner: Unassigned

Title: DEVICE FOR NON-CONTACT TRANSMISSION OF ELECTRICAL SIGNALS
AND/OR ENERGY

PRELIMINARY AMENDMENT

Assistant Commissioner of Patents
and Trademarks
Washington, D.C. 20231

Sir:

Before examination of the above-identified application, please amend the application as follows:

IN THE SPECIFICATION:

Please AMEND the specification as follows:

Page 19, line 8, change "Figs. 8 to 11" to --Figs. 8 to 10--.

IN THE CLAIMS:

Please AMEND the following claims:

Claim 5, line 1, replace "Claim 3 or 4" with --claim 3--.

Claim 6, line 1, replace "any of the Claims 2 to 5" with --claim 1--.

Claim 9, line 1, replace "Claim 7 or 8" with --claim 1--.

Claim 12, line 1, replace "any of the Claims 6 to 11" with --claim 1--.

Claim 15, line 1, replace "any of the Claims 6 to 14" with --claim 1--.

Claim 16, line 1, replace "any of the Claims 1 to 15" with --claim 1--.

Claim 17, line 1, replace "any of the Claims 1 to 16" with --claim 1--.

Claim 18, line 1, replace "any of the Claims 1 to 17" with --claim 1--.

Claim 19, line 1, replace "any of the Claims 1 to 18" with --claim 1--.

Claim 20, line 1, replace "any of the Claims 1 to 19" with --claim 1--.

Claim 21, line 1, replace "any of the Claims 1 to 20" with --claim 1--.

Claim 23, line 1, replace "any of the Claims 1 to 22" with --claim 1--.

Claim 24, line 1, replace "any of the Claims 1 to 23" with --claim 1--.

Claim 25, line 1, replace "any of the Claims 1 to 24" with --claim 1--.

Claim 26, line 1, replace "any of the Claims 1 to 25" with --claim 1--.

Claim 27, line 1, replace "any of the Claims 2 to 26" with --claim 1--.

Claim 28, line 1, replace "any of the Claims 2 to 27" with --claim 1--.

Claim 33, line 1, replace "any of the Claims 29 to 32" with --claim 1--.

Claim 34, line 1, replace "any of the Claims 29 to 33" with --claim 1--.

Claim 35, line 1, replace "any of the Claims 1 to 34" with --claim 1--.

Claim 36, line 1, replace "any of the Claims 1 to 35" with --claim 1--.

REMARKS

This Preliminary Amendment is submitted to improve the form of the claims as originally-filed.

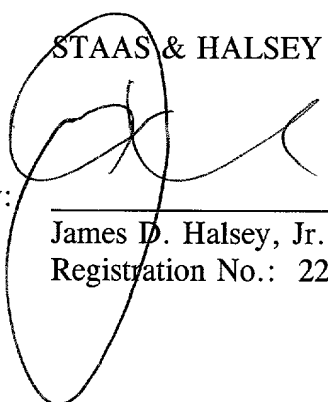
It is respectfully requested that this Preliminary Amendment be entered in the above-referenced application.

If any further fees are required in connection with the filing of this Preliminary Amendment, please charge same to our Deposit Account No. 19-3935.

Respectfully submitted,

STAAS & HALSEY

By:



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Date: June 18, 1999

510 Rec'd PCT/PTO 18 JUN 1999

SR 97/01 PCT

Device for Non-Contact Transmission of
Electrical Signals and/or Energy

DESCRIPTION

Field of the invention

The present invention relates to device for non-contact transmission of electrical signals and/or energy between at least two parts mobile relative to each other, wherein a plurality of defined electromagnetic coupler elements is provided on at least one part, which have a near field inducing the non-contact transmission.

Such devices are used for the transmission of electrical signals or electrical energy, respectively, between two or more parts mobile relative to each other. This movement may be a rotating, a translational or a combined movement.

For the sake of easy understanding a distinction is not made in the present description between the transmission among mutually mobile units and a stationary unit and units mobile relative thereto because this is only a question of local relationship and does not take any influence on the operating mode of the inventive device. Equally, a further distinction is not made between the transmission of signals and the transmission of energy because the operating mechanisms are identical.

Prior art

In units adapted for a translational and particularly linear movement, such as hoisting and conveyor systems, and in ro-

tatable units such as radar installations or computer tomographs it is necessary to transmit electrical signals or energy between mutually mobile units or between one stationary unit and at least one other unit arranged for movement relative thereto.

Whenever the relative speed of the units is comparatively high, for instance, it is expedient to provide a non-contact transmission. Compared against a contacting transmission, e.g. by means of sliding contacts, a non-contact transmission presents additional advantages when high data rates are to be communicated in the transmission of digital signals or when large bandwidths are required for the transmission of analog signals:

In conventional (circular) slip rings the diameter of the slip ring limits the maximum frequency which can be transmitted. This level is reached when the periphery of the Slip ring corresponds to half the wavelength of the signals to be transmitted.

Devices for non-contact transmission of signals or electrical energy are known in the most different configurations. In this respect reference is made to the commonly known textbook by Meinke/Gundlach "Taschenbuch der Hochfrequenztechnik" [*Vademecum of High-Frequency Technology*], Springer-Verlag, Berlin, 1968, page 186 (Resonant Transmitters).

A device supported on this basis and serving for non-contact transmission of electrical signals and/or energy between at least two parts mobile relative to each other, from which the introductory clause of Patent Claims 1 or 3 starts out from, is known from the German Patent DE 42 36 340 C2. In the system for inductive transmission of energy in the range of medium frequencies from a primary coil disposed on a stator to a consumer equipped with at least one secondary coil, which is known from

that prior art document, the primary coil consists of series-connected coils arranged in groups, with one capacitor being connected in series per group. All the groups are connected each in parallel to a medium-frequency distributing line, with the impedances of each group of coils and the respective capacitor being so dimensioned that in the event of an inductive coupling of one group to one of the mobile consumers the resonance condition is satisfied at least approximately for this group.

Even though that known device is very well suited for transmitting electrical energy, it is not appropriate for the wide-band transmission of electrical signals due to the fact that it operates as Resonanzübertrager. Moreover, as a result of the three-dimensional arrangement of the coils, it cannot be employed at operating frequencies in the MHz range and above. This precludes an application in computer tomographs, for instance.

A device for the transmission of electrical signals between two parts which are mobile and particularly rotatable relative to each other along a path and to which a transmitter or a receiver system is connected, and which is particularly intended for application in computer tomographs, is known from the German Patent DE 33 31 722 A1. That known device comprises coupler elements on each part, whereof each includes at least one electrode so that the signal will be capacitively transmitted via the respective opposite electrodes.

That device, which originates from the year 1983, entails, however, also the disadvantage that it is not suitable for transmitting signals with a bandwidth which is required at present for computer tomographs, because reflections occur already at low frequencies on the coupler elements. Even though the use of separate amplifiers for each coupler element would be a remedy

the use of a great number of amplifiers would result in very high costs.

Furthermore the structure via the open coupler elements results in a very high electromagnetic noise radiation.

The laid-open German Patent Application DE-OS 26 53 209 discloses a coaxial multiple rotating coupler for the transmission of high-frequency energy, wherein coupler elements in the form of capacitor plates are used as well, which are permanently engaged by 100 %. This structure results actually in a reflection-free and hence wide-band termination.

On the other hand, the structure of the rotating coupler is complex and hence expensive, particularly when the system should have a wide diameter, e.g. of the size required in computer tomographs.

The German Patents DE 44 12 958 A1 and DE 195 33 819 A1 disclose largely similar devices and methods for a communication at a high data rate, particularly in a computer tomograph system.

To this end, for instance in a computer tomograph, electrical energy is coupled out from a transmission line by means of a coupler, with the line as such assuming the coupler function, i.e. produces the same effect as a leakage line in communications engineering. In this respect reference is made to the aforementioned textbook by Meinke/Gundlach, page 304 (reference word: coupled lines).

These known devices do hence not comprise a plurality of defined coupler elements but merely a strip line so that they pertain to a general type which is different from the type which the introductory clause of Patent Claims 1 or 3 starts out from. The disadvantage of such strip lines is the wide-band

emission of high-frequency energy from the line serving as a coupler:

The lines have a length of up to 4 m, for instance in computer tomographs, and of a multiple thereof in conveyor systems. Therefore it operates as a emitter with a very low lower limit frequency in the event of a slight mismatching already. Due to its extension it is moreover highly sensitive to external noise. This noise is received from the line and communicated to all the other units.

The shield described in the German Patent DE 195 33 819 A1 results only in a slight improvement. Instead of the attenuation by 55 dB at maximum, as described there, a wide-band attenuation by 10 dB with peaks of 20 dB has been determined only in tests.

Another disadvantage of these known methods and devices consists in the aspect that in the event that signals are coupled into the line by the units adapted for relative movement, only a little amount of energy can be transmitted. For improvement of the coupling provisions the surface of the line ought to be enlarged. But this results in a low line impedance and hence in an increased sensitivity to noise.

Brief description of the invention

The present invention is based on the problem of providing a device for non-contact transmission of electrical signals and/or energy between at least two parts adapted for movement relative to each other, which will present a low responsiveness to noise at a large bandwidth or high possible data rates.

One inventive solution to this problem is defined in the parallel Patent Claims 1 and 33. Improvements of the invention are the subject matters of the dependent Claims.

In the inventive approach defined in Claim 1 each of the coupler elements, which are provided on at least one part, contains at least one resonator which consists of a single element able to resonate per se and independently of the other coupler elements. The resonant frequency of the resonator or resonators, respectively, is approximately equal to the frequency of the signals to be transmitted. The individual resonators are interconnected via a line which is terminated in a reflection-free manner. It is thus possible to transmit the signals or the electrical energy to be transmitted, respectively, with a high efficiency at comparatively low losses due to emission. At the same time, the structure of the inventive device is a simple and hence low-cost design. The resonance of the individual resonators may be a serial or parallel resonance.

This provision minimises the interfering emission via the conductor structure.

Claim 2 defines various non-limiting but preferred conceivable resonator designs. One particularly preferred possibility, in addition to the resonant cavities, electric, ferromagnetic and/or piezoelectric resonators, is the application of line resonators because these are simple to design and hence low-cost and which are mainly easy to control.

These line resonators may, for instance, have a comb-shaped arrangement of conducting surfaces on an isolator, with the comb-shaped arrangement being terminated by a defined wave resistor so that, compared against prior art, a wider three-dimensional extension will be possible. This arrangement offers the addi-

tional advantage that it is a simple and hence low-cost design which can be implemented on a "printed circuit board".

There the coupler element, e.g. in the form of a short line section, constitutes a resonator which has particularly expedient coupling properties at its resonant frequency. Such resonators may also be line transformers which provide for impedance matching of the coupler means to the line system. For matching the bandwidth and the quality of resonator systems to the respective transmission project the resonators may be attenuated or may be resonators combined with each other, which are tuned to different resonant frequencies.

In another embodiment of the invention the coupler elements are designed as coupling lines capable of resonating. These are line segments which are not screened and exclusively serve the purpose of coupling.

One alternative solution to the problem defined in accordance with the present invention is defined in Patent Claim 3. In that approach the coupler elements constitute a conductor structure configured as cascade circuit on at least one part, which is provided with a reflection-free termination. Moreover, each coupler element is a resonance system independent of the other coupler elements on that part, which has a resonance frequency higher than the highest frequency of the wide-band signals to be transmitted.

In the present invention a "resonance system" or the "capability to resonate" is to be understood to apply to a resonance which can be used for signal transmission or filtering, respectively.

Within the scope of the present invention a "cascade circuit" is to be understood to apply to the general case of a circuit

quadrupoles but not to a plain series or parallel circuitry. One example of a cascade circuit is the case where the joining coupler element taps the voltage or the current on at least one dummy element of the preceding coupler element as input signal.

In particular, the system formed by the coupler elements may display a low-pass characteristic. The line system has hence conducting properties at low frequencies and presents a very high attenuation at high frequencies so that the inventive device displays a very high resistance to noise. The term "low frequencies" is to be understood here as a frequency band usable for the transmission of signals, which may be within the range up to several 100 MHz to GHz. What is essential of the invention here is the fact that the dimensioning enables the selection of a frequency band useful for the transmission, e.g. between 0 and 300 MHz, whilst frequencies above this frequency band are strongly suppressed.

In any case it is preferred that the conductor structure in its entirety is not able to resonate. This means that the resonators - rather than the conductor structure - have a resonance frequency within the frequency band used for transmission.

For instance, a conductor structure with a length of 100 metres, which includes the resonators having a resonant frequency of 300 MHz, had a resonance at roughly 3 MHz as such. This resonance should not be used for the communication of information and is expediently suppressed.

This minimises the interfering emission via the conductor structure.

In both inventive solutions the parts mobile relative to each other are coupled by means of a plurality of defined electromagnetic coupler elements which are connected to each other by

means of a line or a conductor structure having a reflection-free termination, i.e. which has a defined and matched wave resistance. Thus the disadvantage of a direct influence on the line, which does exist in prior art, is avoided.

Hence the line system can, inter alia, be optimised as means for signal transmission and each of the coupler elements can be optimised separately as means for signal coupling. The line system may consist here of a single line or even of a plurality of inter-connected lines which may also be connected in correspondence with prior art.

A symmetrical structure of the system is preferred.

In the most general case coupling can be implemented by electromagnetic fields and waves and particularly in an inductive and/or capacitive manner. In specific embodiments it is also possible to provide for coupling via merely electrical or magnetic fields.

It is moreover preferred that each coupler element able to resonate consists of one element which contains at least one inductive element and one component producing a capacitive effect.

In particular, each coupler element may consist of a single inductor and a single capacitor. This solution is particularly simple in engineering terms and requires only a low dimensioning expenditure. In this case it is also possible to determine a specific type of coupling. In the embodiment implemented by means of capacitors the coupling is realised predominantly by electrical fields whilst in the embodiment using inductors, by contrast, it is implemented by magnetic fields. It is also possible, of course, to use coupler elements including resonance

circuits of a higher order in which two capacitors, for instance, are connected by two inductors connected in parallel.

The individual inductors of the different coupler elements of one part are preferably connected in series - which a single inductor is used per coupler element - so that the limit frequency of the low-pass system can be easily set to the desired frequency, particularly within the range from 100 to 10,000 MHz. The inductors connected in series hence form the conducting structure themselves so that they do not require any distributing lines as is the case in prior art.

It is furthermore an advantage for the aforementioned frequency range if a continuous and particularly a "straight" line forms the individual inductors.

In any case, the inductors or capacitors may be configured as structures of a printed circuit board so that a particularly simple and low-cost structure is achieved which moreover enables a simple matching with the respective geometry of the parts moving relative to each other.

This purpose is also served with the provision that the printed circuit board is a flexible board because such a board can be easily formed into almost any shape whatsoever - particularly when it presents a specific geometry, e.g. slots. The use of a slotted printed circuit board is, by contrast, naturally not possible in the case of strip lines.

In the design of the inventive device with a printed circuit board it is moreover possible that the capacitors are configured as flat conducting elements on the (flexible) circuit board. The flat conducting elements may be connected to the continuous line via branch lines or joined directly to the line

laterally. It is moreover possible that flat conducting elements are provided on either side of the continuous line.

It is possible in particular to provide conducting structures including a ground surface, capacitors and/or inductors on either side of the printed circuit board.

It is, of course, also possible that the inductors and/or capacitors are discrete elements. Even a combination of discrete elements and elements implemented on a printed circuit board is possible.

In another embodiment of the invention several coupler elements tuned to different frequency ranges are arranged in a close three-dimensional relationship so that a coupler structure is achieved which is tuned to these frequency ranges. With this provision both a wide-band transmission and a multi-channel transmission in several independent frequency bands is possible. This furnishes a coupler structure which enables selective coupling in these predetermined frequency ranges. In an installation, for instance, which operates in the frequency ranges of 100 MHz and 900 MHz, a combination of discrete resonant circuits for the lower frequency band as well as of line resonators for the upper frequency band may be used. On account of such a combination an increased noise suppression can be achieved in the range between these two frequency bands.

In a further embodiment of the invention several coupler elements are so combined with each other that a predetermined radiated field pattern will be obtained outside. This may be done in correspondence with the commonly known rules for the dimensioning of antennas and groups of emitters. The radiation of undesirable energy into particularly sensitive areas can hence be minimised.

The design in which the coupler elements are configured as differential coupler elements and in which a differential signal is applied to the coupler elements enables a signal transmission with a particularly high resistance to noise.

To this end at least two coupler elements must be supplied with differential signals from two lines carrying differential signals or via a symmetrical matching circuitry such as a balance transformer.

In the inventive device coupler elements able to resonate may be provided on all parts, which are matched with each other. It is moreover also possible that coupler elements capable of resonating are provided merely on one part and that conventional transmitters or receivers, respectively, are provided on the other parts as coupler elements. The transmitters or receivers may comprise, for instance, coils, ferrite cores and/or capacitors.

Moreover, the conventional coupler elements may be configured as antennas (emitters) in correspondence with prior art. These antennas can be configured, for instance, as planar antennas with a strip-line design or as rod antennas or frame antennas.

In an advantageous embodiment of the invention the coupler elements presenting the inventive design are arranged on the transmitter side and conventional coupler elements are disposed on the receiving side in the event of a preferred direction of signal flow. Such a preferred signal flow direction is involved, for instance, when exactly one transmitter and at least one receiver are provided or when a transmission quality as high as possible is demanded in precisely one direction. A combination along the path inventive coupler element - coupler element - line system - coupler element - inventive coupler element displays the lowest transmission quality. Here the cou-

pling attenuations of the transition from the conventional coupler element to the inventive coupler element as well as the losses occur twice in the line system. The combination conventional coupler element - inventive coupler element - line system is better because in such a case the losses induced by the transition from the conventional coupler element to an inventive coupler element occur only once. Best, however, is the combination line system - inventive coupler element - conventional coupler element because in such a case the non-amplified signal merely increases the attenuation of the path coupler element -. The signal attenuated by this attenuating factor (e.g. 10 dB) can hence be amplified again directly in the conventional coupler element. In the line system the original signal is still carried at the high level. Along the reverse signal path (conventional coupler element - inventive coupler element - line system) the attenuated signal is guided in the line system where it may be interfered with more easily by other signals on account of its lower level. This consideration leads to the conclusion that the best quality in transmission of a signal can be achieved along the path line system - inventive coupler element - conventional coupler element.

In the inventive device it is moreover expedient to shield line systems serving to feed the signals or the energy to be transmitted or to transmit the transmitted signals or the energy, and to design them hence in a form de-coupled from the coupler elements so that the emission via the feeder systems and the reception of noise energy will be minimised. In correspondence with the invention one embodiment of the device is so sufficient that the coupler elements account for the predominant share in the coupling function. A low remaining coupling of the mobile coupler means with the line system is normally not detrimental. And yet, in certain cases, it may be sensible to shield the line completely. This applies particularly when only

a narrow-band coupling into the line is desired and high noise levels occur within a wide band in the environment.

It is moreover possible to provide at least one activator unit which activate the respective coupler element on the approached part only when the coupler element of a relatively moved part approaches the respective coupler element.

In another advantageous embodiment of the invention the operating range of the coupler elements is matched with the respective transmission task. In the event of resonators used as coupler elements one can dimension them in such a way that they reach their rated resonance frequency only when coupler elements with certain dielectric or magnetic properties are approaching which are provided on a relatively moving part. With this provision the advantage is achieved that energy is released only when these coupler elements are approaching.

When the coupler elements are further remote, for instance in the event of a resonator, the resonator is de-tuned, does not radiate any energy and does not load the line system. A de-tuned resonator is equally not able to couple energy into the line system at its operating frequency. Moreover, the coupler elements may be so designed that they can be tuned to different operating ranges when different coupler means are approaching. For instance, coupler elements provided on a relatively moving part, which have different relative permittivities, are suitable to tune the coupler elements to different operating frequencies.

In a further expedient embodiment of the invention the coupler elements comprise an activator means which determines the approach of a coupler means and activates the respective coupler element in the event of approach.

In another embodiment of the invention the coupler elements are coupled to the line system by additional active or passive components. Such components may be semiconductors in the form of switches or even amplifiers which control the signal flow and/or raise the signal level. Passive components for coupling may be directional couplers which permit the signal flow into the coupler elements, e.g. in the case of unidirectional transmission from the line system, but keep outside noise, which is coupled in by the coupler elements, away from the line system. This applies also in the case that coupler elements are configured as directional couplers. For de-coupling non-reciprocal components such as circulators may be employed, too, of course.

In a further embodiment of the invention different types of coupler elements are combined with each other. For instance, at one point of the system a wide-band transmission with capacitive coupler elements may be required whilst at another point in a noise-troubled environment a narrow-band transmission with resonators is necessary.

It is moreover possible that the coupler elements are shielded by a shield of electrically conductive material. This shield may comprise the coupler elements with or even without the line system or parts thereof. The shield produces its best effect when it encompasses the coupler elements as far as possible.

An inductive or capacitive transmitter means supplementing a resonant circuit displays its optimum transmission characteristics exclusively at the point of the resonant frequency. In accordance with the present invention the circuit is hence supplemented to form a power oscillator in which the resonant circuit used for transmission is the frequency-determining circuit element. It is irrelevant in such a configuration whether the resonant circuit of the transmitter element is a series or a parallel circuit. It can also be configured with further addi-

tional dummy elements so as to form a multi-circuit system able to resonate. What is essential is the fact that the transmission system is so designed that it can be excited to oscillate by combined coupling for oscillation on at least one resonant frequency of the system at which transmission of energy is possible.

The arrangement consists of an amplifying element which supplies the resonant transmitter means. A signalling means determines a signal which contains at least one phase information, based on currents and voltages of the resonance elements, and signals this information to the amplifying element. For the achievement of an oscillatory structure a switching or amplifying component is required in this arrangement which provides for an amplification such that the resonance condition (cf. Tietze, Schenk: "Halbleiterschaltungstechnik" [semiconductor technology], Springer-Verlag, 10th edition, p. 459) will be satisfied. The aspect whether the switching or amplifying component is designed here as a mere semiconductor switch or as a linear amplifying element does not take any influence on the function of the inventive arrangement. Therefore a distinction will not be made in the further text between a switch and an amplifier.

In a particularly advantageous embodiment of the invention the signalling means comprises a power tap which couples out a predetermined percentage of the resonance current in the event of a series resonance. This power tap may be a current meter resistor, a power transformer or a Hall element. The resonance current can equally be measured as voltage drop on one of the resonant elements.

In a further expedient embodiment of the invention the signalling means comprises components for coupling a predetermined share of the voltages out which are applied to the parallel

resonant circuit, in the event of parallel resonance. These voltages can also be determined indirectly via the current flowing through these elements.

In another advantageous embodiment of the invention the signalling means comprises components for determining the combination of a predetermined percentage of at least one parallel resonance voltage or a predetermined share of at least one series resonance current in the case of a multi-circuit resonance system. The signalling means can be designed in this case such that the analysis will be performed by a simple addition, free from phase errors, of these magnitudes. With this provision it is possible to have the circuit operate at series or parallel resonance, depending on the respective load case. As an alternative also a reversing switch is possible which recognises whether a series or a parallel resonance is involved and which determines a share of the resonance voltage or the resonance current, respectively, in correspondence therewith.

In a further expedient embodiment of the invention the signalling means comprises filter elements for a pre-selection between the collection of the resonance voltage or the resonance current.

In a further advantageous embodiment of the invention the signalling means comprises a secondary oscillator which facilitates the commencement of oscillation of the system when the supply voltage is turned on. It is common that upon turn-on of the supply voltage an oscillator begins to oscillate from the noise condition. To ensure a reliable and rapid start of the oscillation such an oscillator can also receive a starting signal at a predetermined frequency. When this frequency is selected in the vicinity of the desired operating frequency the oscillation commences particularly rapidly. In the case of several possible resonances, too, the oscillation can take place

at the desired resonance frequency when the starting signal is determined. If in such a case the oscillator started to oscillate from the noise condition it may be that the power oscillator also starts to oscillate to undesirable resonance frequencies.

In another expedient embodiment of the invention a further analyser unit is provided which uses the operating frequency of the circuit as such for determining the spacing between the parts movable relative to each other. With the operating frequency varying as a function of the mutually mobile elements in the case of an inductive transmission the corresponding variation of the distance can be easily determined on the basis of the operating frequency.

Brief description of the drawings

The invention will be described in more details in the following with reference to the drawing wherein:

Figs. 1a to 1c show the fundamental structure of inventive devices for non-contact transmission of electrical signals and/or energy;

Fig. 2 illustrates a first embodiment of the invention which comprises a capacitive coupling system;

Fig. 3 shows a variant of the embodiment illustrated in Fig. 2, which comprises a balanced system with shielding;

Fig. 4 is a view of a second embodiment with an inductive coupling system;

Fig. 5 illustrates an inventive device on a rotary transformer;

Figs. 6a and 6b show a comparison between a prior art device and an inventive device in differential signal transmission;

Figs. 7a and b are illustrations for explanation of the low-pass characteristic; and

Figs. 8 to 11 illustrate various examples of resonance coupling.

Description of embodiments

In the following figures the same reference numerals have been used to denote identical elements or elements producing the same effects so that partly a repeated discussion may be omitted here.

Figs. 1a to 1c show various embodiments of the inventive device for non-contact transmission of electrical signals and/or energy, with the transmitter only being represented in the Figures, rather than the receiver as well.

A signal source S is connected via a conductor structure 2 to coupler elements C or L , respectively, and are furthermore terminated by a surge impedance Z_0 in a manner free from reflection. When a unit of the inventive structure is used as receiver the transmitted signal is tapped at the position of the signal source S . The arrangements illustrated here present a symmetrical or balanced configuration because here a particularly expedient embodiment is involved. Unbalanced or non-symmetrical embodiments are, of course, conceivable as well.

Fig. 1a shows an example of capacitive coupling; in this case flat conducting elements C , which induce the capacitive coupling, are connected to a continuous conductor 2 via a branch line or directly as in the embodiment illustrated here.

Fig. 1b illustrates an example of inductive coupling; here the conductor structure 2 forms loops and hence discrete elements L which create the inductive coupling.

Fig. 1c is the view of an example of inductive and capacitive coupling; in this case both the conductor loops L and flat conducting elements C are provided.

The invention will be explained in more details in the following with reference to the other Figures.

Figure 2 shows an embodiment with capacitive coupling in a non-symmetrical design. On a carrier 1, e.g. a printed circuit board which may be flexible in particular, a conductor structure or a line network 2 is provided which interconnects the capacitive coupler elements 3a, 3b, and 3c.

Electrical signals and/or energy are transmitted by means of these coupler elements and by a coupler means 4 which serves as receiver and which is mobile relative to these coupler elements. The coupler means 4 can, of course, involve elements of a similar design but also conventional receivers. In the illustrated embodiment - here reference is made to the side view in Fig. 2 - the coupler means 4 is a conventional receiver which is disposed at the side of the coupler elements 3a to 3c. A ground surface may be optionally provided on the rear side of the printed circuit board.

Fig. 3 is a cross-sectional view of a variant of the embodiment illustrated in Fig. 2, wherein a symmetrical arrangement with a shielding is provided. The device comprises a balanced line system or a balanced line structure, respectively, which consists of a first conductor 2 and a second conductor 12. These conductors supply capacitive coupler elements 3 and 13.

The coupler means 4 is designed here as a balanced coupler means which surrounds the printed circuit board 1 in a U-shaped configuration, on which the conductor structures and the coupler means are arranged. Furthermore, a shielding 6 is provided to surround the entire arrangement. The carrier 1, which may be a printed circuit board again, is fastened on the shield 6 by means of isolators 5 and 15.

Figure 4 is a view of a second embodiment of the invention wherein an inductive coupling is realised. On a carrier 1, which may also be provided with an electrically conductive layer on the rear side, a conductor structure 2 is provided, too, which connects inductive coupler elements 3a to 3c. The coupler elements 3a to 3c are configured here in the manner of a conductor loop. The reference numeral 4 denotes again a coupler means of the conventional type.

The inventive device of which an exemplary description has been given above with reference to Figs. 1 to 4 presents a number of advantages as will be explained in more details below, with reference being made to Figs. 5 to 7.

Fig. 5 shows an embodiment wherein the inventive device is so configured that it may be mounted on a rotary transformer, for instance. The conductor structure 2 having the inventive design with capacitive elements 3 (and/or inductive elements) may be made of a plane film or foil or the printed circuit board 1 in which slots are produced so as to allow for bending to small radii. This were impossible with a strip line as it is common in prior art.

Moreover, the inventive device presents the advantage that with a bent arrangement and with a differential signal coupling only slightly different line lengths are obtained which lead to dif-

ferences in delay times and hence in signal noise and undesirable radiation. The inventive device is thus particularly well suitable for the transmission of differential signals, which entails the further advantage that the radiation to the outside is minimised due to the fields in the outside space which compensate each other practically almost completely.

Fig. 6 shows a comparison between conventional strip lines SL designed as differential structure (figure section a) and an inventive device (figure section b).

As becomes apparent from Figures 6a and 6b the lines 2 and 12 with coupler elements 3 and 13 are disposed very close to each other in the case of an inventive device so that the difference of their radii r_1 and r_2 is very small and hence the difference in delay times becomes comparatively great.

Fig. 7a shows a simplified electrical equivalent circuit diagram of an inventive device. As is shown in Fig. 7a, the inventive device presents a low-pass characteristic. Thus the inventive device entails the advantage of a high resistance to noise because any noise above the threshold frequency will not be passed on and can hence neither be received nor emitted.

Fig. 7b is an exemplary illustration of the computed frequency response of an inventive device, wherein the frequency is plotted (in MHz) along the abscissa and the received signal (in V) is plotted on the ordinate. As is apparent here the inventive device presents a practically constant frequency response between 1 MHz and almost 300 MHz, which steeply drops to "zero" at roughly 300 MHz in the illustrated embodiment. Threshold frequencies other than 300 MHz - be they higher or lower - can, of course, be implemented as well.

Fig. 8 is an illustration of an inventive arrangement with resonance coupling, which consists of an inductive or capacitive coupler element 83, respectively, which supplies a consumer 84. This coupler element is supplemented with at least one dummy element 82 to form a structure able to resonate. The signalling means 85 generates a regenerative coupling signal from resonance currents or voltages at the coupler element or at the supplementing dummy elements, which signal has such an amplitude and such a phase that the switching or amplifying element 81, together with the dummy elements 82 and 83 joining it, satisfies the condition of oscillation.

Fig. 9 is an exemplary illustration of an arrangement in correspondence with the invention for the case of a capacitive transmission means. The capacitive coupler element 93 supplies the consumer 94. It is supplemented by the inductor 92 for forming a structure capable of resonating. In this case the signalling means consists of a current meter resistor 95 which transmits a signal proportional to the series resonance current to the switching or amplifying component 91 by inductance and capacitance.

Fig. 10 shows an example of a particularly simple embodiment of an inventive system in the case of parallel resonance on an inductive coupler element. In this case the inductive coupler element 103 supplies a consumer 104. The inductor is supplemented by the capacitor 102 so as to form a parallel resonance circuit. This signalling means consists here of a voltage divider with the two resistors 105 and 106, which taps a predetermined share of the parallel resonance voltage by inductance and capacitance and passes them on to the switching or amplifying component, respectively.

The present invention has so far been described by exemplary embodiments without any restriction of the general inventive

idea and general applicability. In particular, it is possible to employ the invention not only for rotary transformers such as in computer tomographs, radar towers etc. but also for transformers adapted for linear movement such as those required on cranes etc. Moreover, the invention may be used in transformers performing a composite movement.

PATENT CLAIMS

1. Device for non-contact transmission of electrical signals and/or energy between at least two parts mobile relative to each other, wherein a plurality of defined electromagnetic coupler elements is provided on the parts between which signals and/or energy is to be communicated, with the near field of these coupler elements causing the non-contact transmission,
characterised in that each of said coupler elements, which are provided on at least one part, comprises at least one resonator consisting of a single element able to resonate per se and independently of the other coupler elements, which has a resonance frequency approximately equal to the frequency of the signals to be transmitted, and
- that the individual resonators are connected to each other via line which is terminated in a manner free from reflection.
2. Device according to Claim 1,
characterised in that said resonator or resonators is/are resonating cavities, line resonators, dielectric, ferromagnetic and/or piezoelectric resonators.
3. Device for non-contact transmission of electrical signals and/or energy between at least two parts adapted to be moved relative to each other, wherein a plurality of defined electromagnetic coupler elements is provided on the parts between which signals and/or energy are to be transmitted, with the near field of said coupler elements causing the non-contact transmission,
characterised in that said coupler elements on at least one part

- form a conductor structure configured as cascade circuit which is terminated in a manner free from reflection, and
 - that each coupler element, independently of the other coupler elements, is a resonance system having a resonance frequency higher than the highest frequency of the wide-band signals to be transmitted.
4. Device according to Claim 3,
characterised in that the system formed by said coupler elements presents a low-pass characteristic.
 5. Device according to Claim 3 or 4,
characterised in that said conductor structure in its entirety is not capable of resonating.
 6. Device according to any of the Claims 2 to 5,
characterised in that each coupler element able to resonate consists of an element including at least one component producing an inductive and capacitive effect, and that the joining coupler element taps the voltage or the current, respectively, on at least one dummy element of the preceding coupler element as input signal.
 7. Device according to Claim 6,
characterised in that each coupler element is composed of at least one, preferably a single, inductor and at least one capacitor.
 8. Device according to Claim 7,
characterised in that the individual inductors of the various coupler elements of one part are connected in series.

9. Device according to Claim 7 or 8,
characterised in that a continuous line forms the individual inductors of the respective coupler elements.
10. Device according to Claim 9,
characterised in that the capacitors are configured as flat conducting elements which are connected to said continuous line via branch lines or are directly joined to the line laterally.
11. Device according to Claim 10,
characterised in that flat conducting elements are provided on either side of said continuous line.
12. Device according to any of the Claims 6 to 11,
characterised in that said inductors or capacitors are configured as structures of a printed circuit board.
13. Device according to Claim 12,
characterised in that said printed circuit board is a flexible board.
14. Device according to Claim 13,
characterised in that said printed circuit board is provided with slots.
15. Device according to any of the Claims 6 to 14,
characterised in that said inductors and/or capacitors are discrete elements.
16. Device according to any of the Claims 1 to 15,
characterised in that several coupler elements tuned to different frequency ranges are disposed in a close three-dimensional relationship such that a coupler structure is achieved which is tuned to these frequency ranges.

17. Device according to any of the Claims 1 to 16,
characterised in that said structure is symmetrical.
18. Device according to any of the Claims 1 to 17,
characterised in that conductor structures with a ground surface, capacitors and/or inductors are provided on either side of a printed circuit board.
19. Device according to any of the Claims 1 to 18,
characterised in that said coupler elements are configured as differential coupler elements and
that a differential signal is applied to said coupler elements.
20. Device according to any of the Claims 1 to 19,
characterised in that coupler elements able to resonate and matched with each other are provided on all parts.
21. Device according to any of the Claims 1 to 20,
characterised in that coupler elements able to resonate are provided on one part, and
that conventional transmitters or receivers are provided as coupler elements on the other parts.
22. Device according to Claim 21,
characterised in that said transmitters or receivers, respectively, comprise coils, ferrite cores and/or capacitors.
23. Device according to any of the Claims 1 to 22,
characterised in that the signals or the energy to be transmitted for supply or the line systems, respectively, which serve to pass on the transmitted signals or the energy are shielded and thus designs de-coupled from said coupler elements.

24. Device according to any of the Claims 1 to 23,
characterised in that at least one activator unit is provided which activates the respective coupler element only when the coupler elements of a relatively moved part are approaching.
25. Device according to any of the Claims 1 to 24,
characterised in that said coupler elements are so designed that they adjust themselves in terms of their electrical characteristics to their operating point only by the dielectric or magnetic characteristics of an approaching coupler element.
26. Device according to any of the Claims 1 to 25,
characterised in that the coupling of said coupler elements to said line system is performed by additional active or passive devices such as amplifiers and/or semiconductor switches.
27. Device according to any of the Claims 2 to 26,
characterised in that said coupler elements are shielded from the environment by a shield made of an electrically conductive material.
28. Device according to any of the Claims 2 to 27,
characterised in that said coupler elements are supplied by a switching or amplifying element.
29. Device according to Claim 28,
characterised in that an additional signalling means is provided which generates a regenerative coupling signal for said switching or amplifying element, on the basis of voltages and currents of the resonant elements, such that oscillation will occur on at least one resonance frequency.

30. Device according to Claim 29,
characterised in that said signalling means is so configured that it couples out one magnitude proportional to one part of a series resonance current.
31. Device according to Claim 29,
characterised in that said signalling means is so designed that it couples out one magnitude proportional to one part of a parallel resonance voltage.
32. Device according to Claim 29,
characterised in that in the case of several resonances said signalling means is so designed that it couples out a combined signal consisting of a magnitude proportional to a series resonance current and proportional to a parallel resonance voltage.
33. Device according to any of the Claims 29 to 32,
characterised in that an additional secondary oscillator is provided to facilitate the commencement of the oscillation of the circuit.
34. Device according to any of the Claims 29 to 33,
characterised in that an analyser means is provided which determines the operating frequency of the system and derives therefrom a signal in correspondence with the size of the spacing of said units adapted to be moved relative to each other.
35. Device according to any of the Claims 1 to 34,
characterised in that said parts adapted to be moved relative to each other perform a rotating movement.

36. Device according to any of the Claims 1 to 35,
characterised in that said parts adapted to be moved relative to each other perform a translational movement.

ABSTRACT OF THE DISCLOSURE

What is described here is a device for non-contact transmission of electrical signals and/or energy between at least two parts mobile relative to each other, wherein on the parts between which signals and/or energy are to be transmitted a plurality of defined electromagnetic coupler elements is provided whose near field causes the non-contact transmission.

The inventive device excels itself by the provisions that the coupler elements on at least one part

- form a conductor structure configured as cascade circuit terminated in a manner free from reflection, and
- that each coupler element, independently of the other coupler elements on this part, is a resonator system having a resonance frequency higher than the highest frequency of the wide-band signals to be transmitted.

An alternative embodiment is characterised by the provision that each of the coupler elements provided on at least one part comprises at least one resonator which consists of a single element able to resonate per se and independently of the other coupler elements and has a resonance frequency approximately equal to the frequency of the signals to be transmitted, and

- that the individual resonators are connected to each other via line terminated in a manner free from reflection.

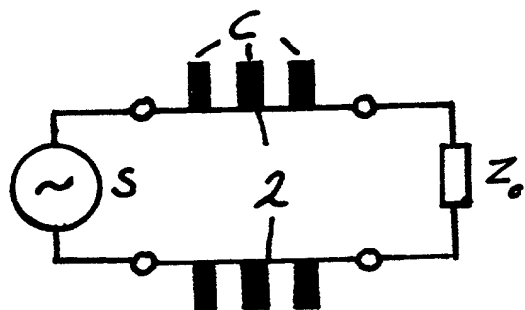
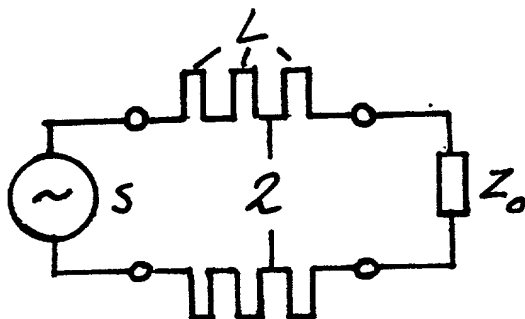
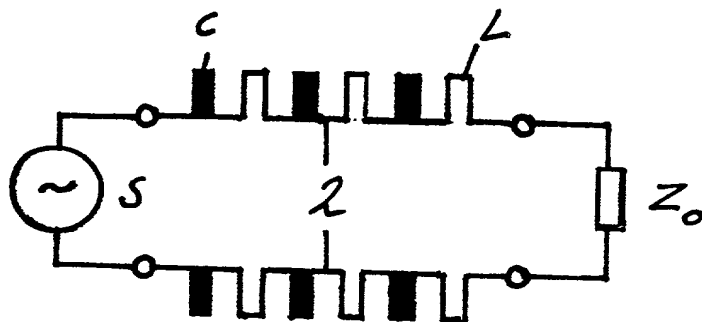
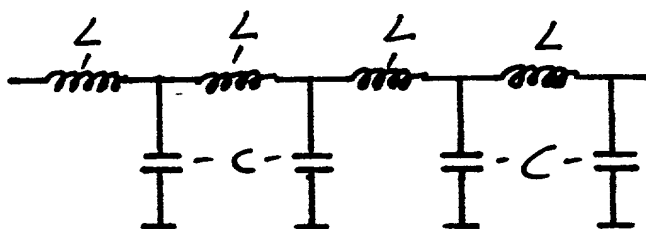
Fig. 1aFig. 1bFig. 1cFig. 7a

FIG. 2

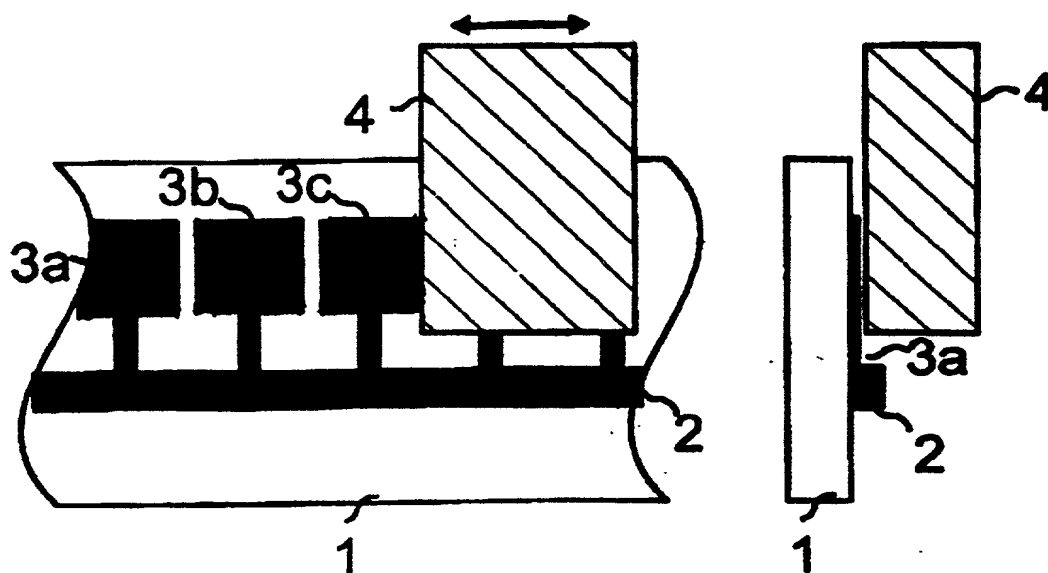
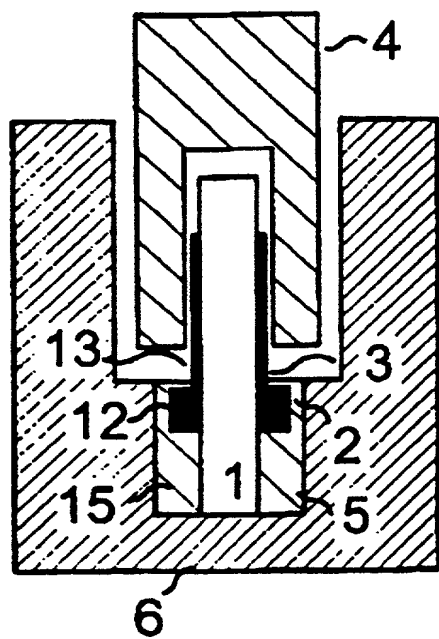


FIG. 3



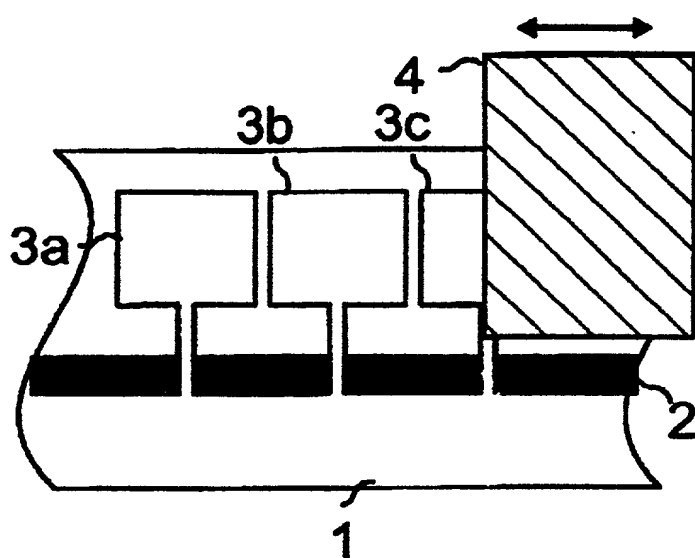
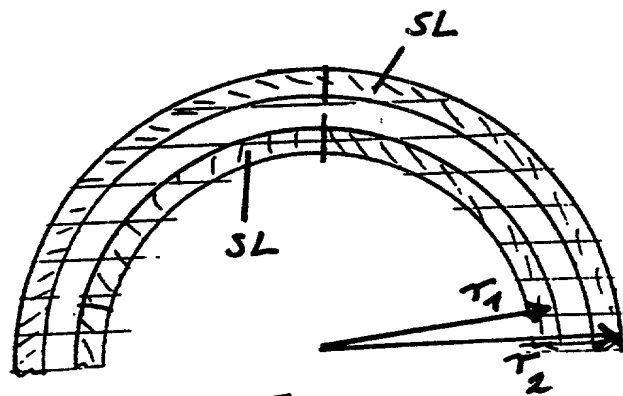
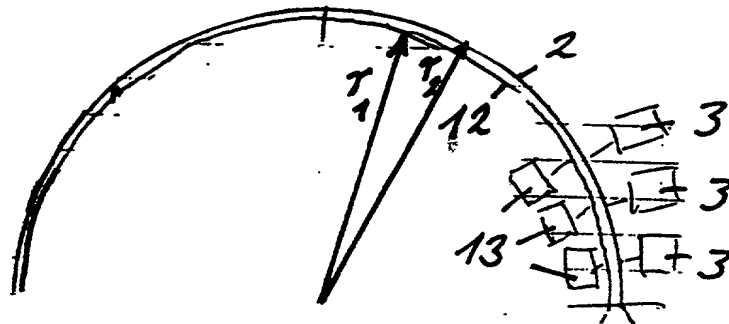
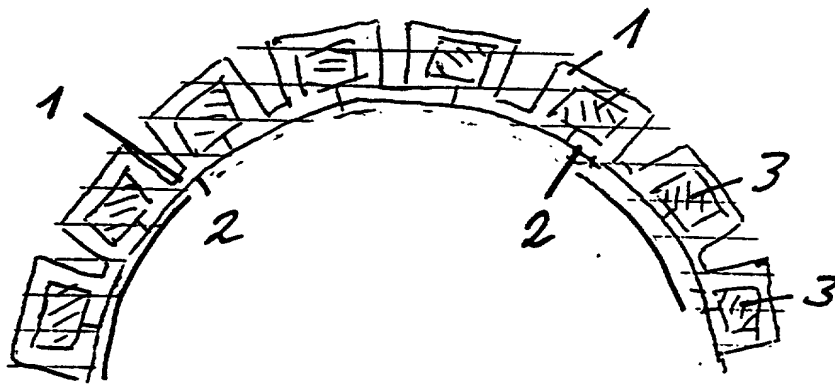


FIG. 4

Fig. 6aFig. 6bFig. 5

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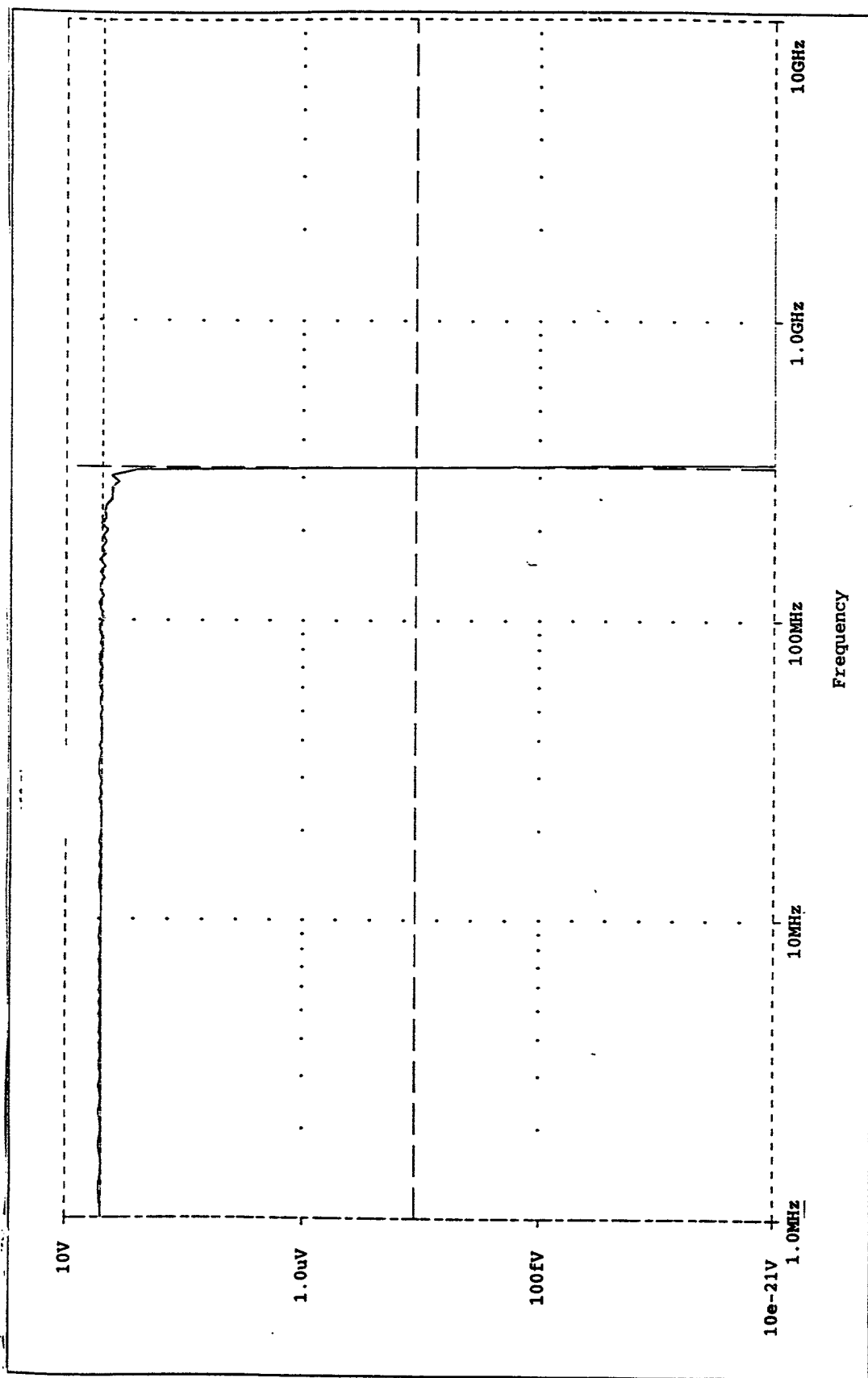
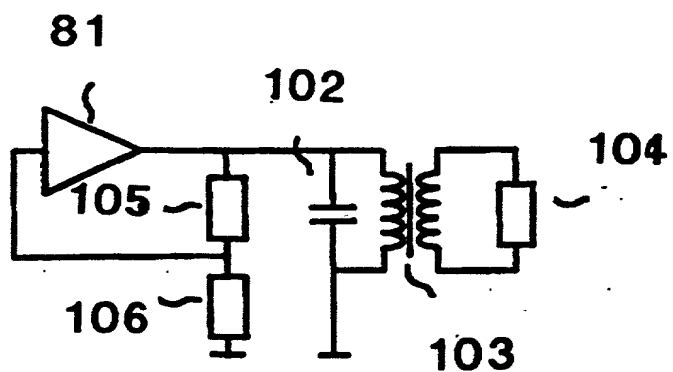
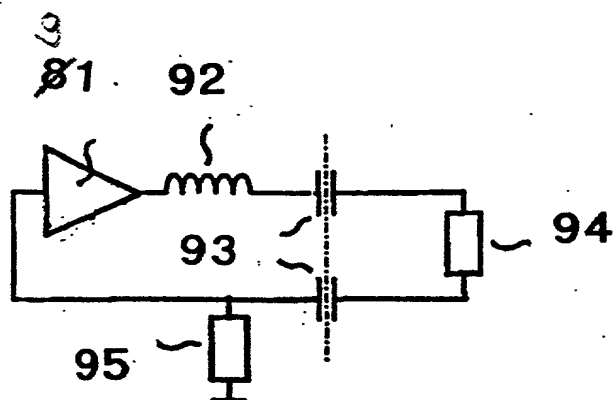
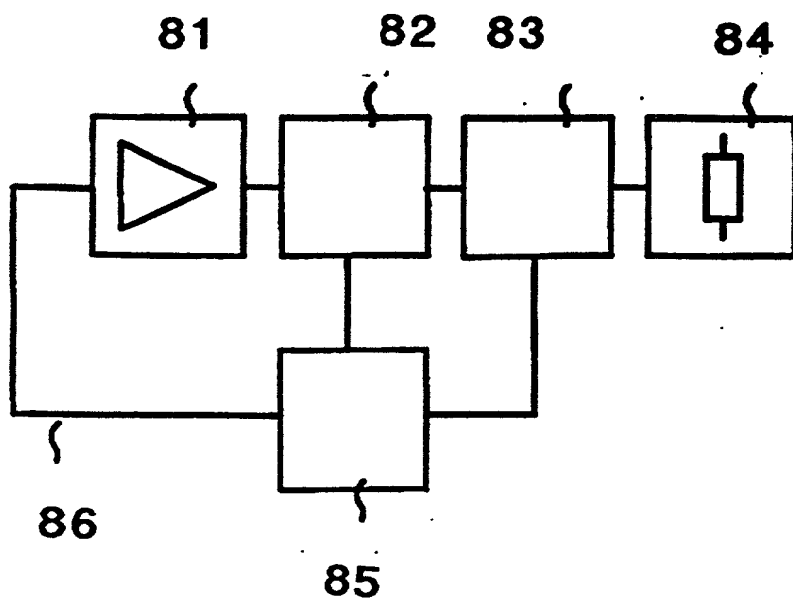


Fig. 7b



As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

DEVICE FOR NON-CONTACT TRANSMISSION OF ELECTRICAL SIGNALS AND/OR ENERGY

the specification of which (check only one item below)

☐ is attached hereto.

☐ was filed as United States application

Serial No. _____

on _____

and was amended

on _____ (if applicable).

DO was filed as PCT international application

Number PCT/DE98/00512

on June 17, 1999

and was amended under PCT Article 19

on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

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COUNTRY (if PCT, indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
DE	197 00 110.6	3-1-97	DO YES <input type="checkbox"/> NO
DE	197 01 357.0	16-1-97	DO YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s), in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS		STATUS (Check one)		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED
PCT APPLICATIONS DESIGNATING THE U.S.				
PCT APPLICATION NO.	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (if any)		

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the U.S. Patent and Trademark Office connected therewith. (List name and registration number.) James D. Maloney, Jr., 22,729; Harry John Staas, 22,010; David M. Pitcher, 25,908; John C. Garvey, 28,607; J. Randall Beckers, 30,358; William P. Herbert, 31,024; Richard A. Gallhofer, 31,106; Mark J. Henry, 36,162; Gene M. Garner II, 34,172; Michael D. Stein, 37,240; Paul I. Kravetz, 35,230; Gerald P. Joyce, III, 37,648; Todd E. Mariotte, 39,269; Marlan B. Williams, Jr., 34,756; George N. Stevens, 36,938; Michael C. Goldner, 41,455; Norman L. Durada, 41,235; Kevin R. Spivak, 43,148 and William M. Schertler, 35,348 (agent)

201	FULL NAME OF INVENTOR	FAMILY NAME LOHR	FIRST GIVEN NAME Georg	SECOND GIVEN NAME
	RESIDENCE & CITIZENSHIP	CITY Eichenau	STATE OR FOREIGN COUNTRY Germany	COUNTRY OF CITIZENSHIP Germany
	POST OFFICE ADDRESS	POST OFFICE ADDRESS Allinger Str. 75	CITY D-82223 Eichenau	STATE & ZIP CODE/COUNTRY Germany

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202
DATE June 30. 1999	DATE	DATE

D E C L A R A T I O N

I, Dr. Wilhelm MÜNICH, Patent Attorney, Wilhelm-Mayr-Str. 11, 80689 Munich, GERMANY, do hereby declare that I am conversant with the English and German languages and I am a competent translator thereof. I declare further that to the best of my knowledge and belief the following is a true and correct translation made by me of the document in the German language attached hereto.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Signed this 10th day of June 1999


.....

Dr. Wilhelm Münich